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Title: APPARATUS AND METHOD FOR HOLDING A PIECE IN A BORE

Inventor: Zdravko KOVAC
Chesterfield, MI

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of provisional application No. 60/415,145 filed October 2, 2002; 60/415,240 filed October 2, 2002, and 60/415,203 filed October 2, 2002, all incorporated herein by reference.

BACKGROUND OF THE INVENTION

This invention relates to an apparatus and method for holding a piece in a bore, The invention will be described in its application to the use of a fastener retainer for holding a fastener, such as a bolt, in a bore of a body, such as a panel, for example, but it will become apparent that the invention has broader utility.

The use of fastener retainers to pre-attach bolts, studs, or other fasteners to a workpiece, such as a panel, in preparation for a subsequent assembly operation is well known. Such pre-attachment improves production efficiency by eliminating the need for manual placement of the

fasteners as parts of the assembly operation. In a typical application, a bolt (or other fastener) is inserted into a plastic annular retainer which is designed to retain the bolt within a smooth-walled bore of a workpiece. The retainer, which has an outer diameter slightly larger than that of the bore, is pressed into the bore, where it is held by resilient frictional engagement with the bore wall, thus pre-attaching the bolt to the workpiece. The workpiece may subsequently be associated with a second workpiece having a threaded bore which is axially aligned with the bore of the first workpiece, and the two workpieces may then be securely assembled to each other by engaging the bolt with the threaded bore of the second workpiece. See, for example, U.S. Patent Nos. RE 36,164 and 6,039,525.

In practical use of such retainers, it is often important that the holding power of the retainer to the fastener and the holding power of the retainer to the workpiece bore be such that the retained fastener may, if inadvertently bumped, slide axially of the retainer without the retainer slipping out of the workpiece bore. It is also desirable to provide a retainer that accommodates misalignment of the bores and that permits the fastener to

be tilted relative to the axis of the retainer. Furthermore, it is desirable that the design of the retainer readily accommodate varying requirements for retainer holding power and varying fastener and bore diameters, and that the retainer be capable of being manufactured simply and economically.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved apparatus and an improved method for holding a piece in a bore.

It is another object of the invention to provide an improved assembly of a piece to be held in a bore and a piece-holding device, and more particularly, an improved assembly of a fastener retainer and a fastener.

It is a further object of the invention to provide an improved combination of a body having a bore therein, a piece-holding device inserted in the bore, and a piece inserted in and held by the piece-holding device, and more particularly, to an improved combination of a body having a bore therein, a fastener retainer, and a fastener.

It is another object of the invention to provide an improved assembly of the foregoing type, an improved

combination of the foregoing type, and an improved method for holding a piece in a bore in which the piece-holding device is readily adaptable to varying requirements for holding power and is capable of being manufactured simply and economically.

The foregoing objects, as well as other aspects, features and advantages of the invention, will be more fully appreciated from the following description of preferred embodiments taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a piece-holding device useful in the invention;

Fig. 2 is a side elevation view of the piece-holding device of the first embodiment;

Fig. 3 is an end view of the piece-holding device of the first embodiment;

Fig. 4 is a sectional view taken along line 4-4 in Fig. 3;

Fig. 5 is an end view of a second embodiment of a piece-holding d vice useful in the invention;

Fig. 6 is a sectional view taken along line 6-6 in Fig. 5;

Fig. 7 is an end view of a third embodiment of a piece-holding device useful in the invention;

Fig. 8 is sectional view taken along line 8-8 in Fig. 7;

Fig. 9 is an end view of a fourth embodiment of a piece-holding device useful in the invention;

Fig. 10 is a plan view of the piece-holding device of the fourth embodiment;

Fig. 11 is a sectional view taken along line 11-11 in Fig. 9; and

Fig. 12 is an exploded perspective view showing the use of the invention with a retainer of the fourth embodiment and a bolt.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in Figs. 1-4, a first embodiment of a device 10 useful in an assembly, combination, and method according to the invention comprises a cylindrical sleeve 12 having a series of fins 14 extending longitudinally of an inner surface 16 of the sleeve and projecting inwardly from the inner surface. The fins ar spaced from each other

circumferentially of the sleeve with tips 18 extending along the length of the sleeve and disposed to engage an outer surface of a piece inserted into the sleeve, as later described. In the embodiment there are nine fins, but the number of fins can be varied to meet the need of particular applications of the invention.

The sleeve and the fins are integrally formed of a resilient flexible plastic, e.g., a polyester elastomer, and are preferably skewed in a same circumferential direction relative to radial planes of the sleeve. The inclination angles of the fins are preferably uniform. The flexibility of the fins is such that the fins can be readily deflected when engaged by an inserted piece. For this purpose, the dimension of each fin along the direction of its inward projection is preferably substantially greater than the thickness of the fin.

In order to facilitate insertion of the retainer into a bore, either or both of end portions 20 of the sleeve are chamfered. Accordingly, the end portions of the sleeve have an outer diameter that increases away from the respective longitudinal ends of the sleeve.

In the first embodiment, the longitudinal ends 22 of the fins are spaced from the longitudinal ends,

respectively, of the sleeve. The end portions 20 of the sleeve have an inner diameter that slightly increases between the respective longitudinal ends of the sleeve and the fins.

To facilitate the insertion of a bolt or other fastener (e.g., a pin or stud) into the retainer, the fins are preferably tapered. To provide the desired taper of the fins, the longitudinal ends 22 of the fins extend away from the respective longitudinal ends 24 of the sleeve and away from the inner surface 16 of the sleeve. The longitudinal side surfaces 26 of the fins are preferably trapezoidal. The longitudinal ends of the sleeve are preferably flat. If the bolt or other fastener is sufficiently tapered at its leading end, the fins need not be tapered, i.e., the longitudinal side surfaces 26 of the fins may be rectangular.

Figs. 5 and 6 illustrate a second embodiment of a piece-holding device useful in the invention, which is similar to the first embodiment except that the inner diameter of the end portions of the sleeve is uniform between the longitudinal ends of the sleeve and the ends of the fins.

Figs. 7 and 8 illustrate a third embodiment of a piece-holding device useful in the invention, in which the fins extend all the way to the longitudinal ends of the sleeve.

Figs. 9-11 illustrate a fourth embodiment of a piece-holding device useful in the invention. In this embodiment, the fins are similar to the fins of the third embodiment, but at three locations spaced 120° apart abutments 28 are provided, the ends of which are spaced from the respective longitudinal ends of the sleeve.

In all of the embodiments described, the piece-holding devices used in the assemblies, combinations, and methods of the invention can be manufactured by injection molding of a plastic such as high-density polyethylene. In the embodiment of Figs. 9-11, the longitudinal ends of the abutments 28 may engage ejector pins of molding apparatus to eject the molded retainer from a mold. In the form shown, slots 30 are provided in the sleeve for insertion of the ejector pins. The slots may be eliminated if the inward projection of the abutments 28 is sufficient to permit the ejector pins to engage substantially flat surfaces of the abutments internally of the sleeve 12. Th inward projection of the abutments (toward the axis of the

sleeve) is less than the inward projection of the fins by an amount that is sufficient to ensure that the abutments do not engage a bolt or other fastener inserted axially into the sleeve 12. Opposite longitudinal ends of the abutments may be chamfered or tapered to minimize obstruction to insertion of a fastener in the event of axial misalignment of the fastener with the retainer during insertion.

Fig. 12 illustrates an assembly, combination, and method of the invention using a retainer 10 of the fourth embodiment (representative of the use of all embodiments) for holding a bolt 32 in a bore 34 of a body 36. Typically, the retainer will be pre-assembled with the bolt, and the resulting pre-assembly then inserted into and frictionally engaged with the bore of the body, thus pre-attaching the bolt to the body. However, the retainer may first be pressed into the bore and then the bolt inserted into the retainer.

The outer diameter of the sleeve 12 is slightly greater than the inner diameter of the bore 34 to allow for resilient frictional engagement of the sleeve with the wall of the bore. The diameters of the outer surface of the sle ve and the bore wall are preferably sufficiently close

to one another to avoid buckling of the sleeve within the bore, whereby essentially the entirety of the cylindrical outer surface of the sleeve between the chamfered ends will be in engagement with the complementary cylindrical inner surface of the bore.

When the shank 38 of the bolt is pressed into the retainer, the outer surface of the shank (typically the crests of the threads in the case of a bolt) engages the tips of the fins 14 and thereby deflects the fins circumferentially and slightly outwardly. As a result, the fins center the bolt within the sleeve of the retainer and hold the bolt within the retainer. As is apparent in Fig. 12, the bolt may project from the bore 34 of the body 36 for engagement with a threaded bore 40 of a second body 42, thereby to join the second body to the first body. The bodies may be panels to be joined, for example. The construction of the invention accommodates misalignment of the bolt and the retainer as well as misalignment of the bodies to be joined. It is preferred that the frictional force between the outer surface of the sleeve of the retainer and the inner surface of the bore be greater than the frictional force betwe n the bolt and the retainer, so

that adjustment of the bolt relative to the retainer does not shift the retainer relative to the bore.

As a non-limiting example of dimensions of a piece-holding device useful in an assembly of the invention with an M6 bolt, the axial length of the sleeve may be about 5.0 mm., and the outer diameter of the sleeve may be about 8.75 mm with a sleeve wall thickness of about 0.625 mm. The fin thickness may be about 0.46 mm. The inward extension of each fin along one trapezoidal side may be about 1.559 mm and along the opposite trapezoidal side may be about 1.270 mm. Thus, the inward extension of each fin is substantially greater than the thickness of the fin (about three times as great in the embodiment). Also, in the embodiment the fin thickness is substantially uniform, except at the pointed tip. An angle between a radius and the shorter trapezoidal side of a fin may be about 31° 24' 15". An angle defined between radii extending through the intersections of the shorter trapezoidal sides of adjacent fins with the inner surface of the sleeve may be about 40°. The axial length of each fin at its tip may be about 2.9 mm. In their relaxed state, the tips of the fins may lie tangentially on a circle with a diameter of about 5.494 mm.

In the fourth embodiment, the axial length of each abutment 28 may be about 2.99 mm.

While preferred embodiments of the invention have been shown and described, those skilled in the art will recognize that various changes can be made without departing from the principles and spirit of the invention, the scope of which is defined in the appended claims. For example, an assembly or combination of the invention may comprise a group of piece-holding devices and a pin or stud held by such devices in a long bore. As a further example, a device used in a method of the invention may be used as a spacer or a washer and may be used in multiples to provide a group of such devices spaced apart, e.g., for holding a pin or stud in a long bore.